Repair, don't replace, burner-register linkages

Appalachian Power Co's (APC) Amos station has two 800-MW supercritical boilers, both installed in the early 1970s. Each produces 5.28-million lb/hr of 3515-psig/1010F main steam. After 20 years, normal wear and tear on the burner air registers have contributed to poor control-setting repeatability for the electric-actuator-driven secondary-air vanes. Proper register settings are crucial to establishing correct flame shape and stability. Improper register settings can lead to poor combustion efficiency, increased particulate emissions, accelerated slagging, and tube wastage.

Problem. Close inspection by Amos plant engineers revealed substantial wear on the circumferential linkage assembly that connects all the secondary-air vane levers and permits simultaneous opening and closing of all vanes (Fig 1). The original hardware for each assembly includes sixty-six 7.5-in.-long carbon steel links that attach tangentially to the vane levers. At the end of each link is a 0.38-in.-diameter hole through which a loose link pin connects the link to a vane lever. The pin is secured by a washer and cotter pin at each end. Years of normal wear enlarged the holes in both the vane arms and links, resulting in excessive "play" between components—and vane settings that were off by up to 40%.

Solution. Changing all of the vane arms would have been an expensive and time-consuming task—a conservative estimate of total cost for this option is a $500,000 per boiler. Instead, Engineers John Lester and Wayne Purdue teamed with Steve Buchanan of APC's parent firm, American Electric Power Service Corp (AEP), to implement a solution that cost only $20,000 for both boilers, including parts and labor.

Amos personnel welded two stainless steel link pins at the end of each lever. New links were then installed. These were identical to the originals except the end holes were drilled to have a diameter only 0.01 in. larger than that of the connecting pins. This tighter clearance both reduces play and limits the excessive wear rates associated with a loose, uneven fit. When the assembly does eventually wear, only the carbon-steel links should require replacement—instead of both the links and the vane arms, as was the case with the original design.

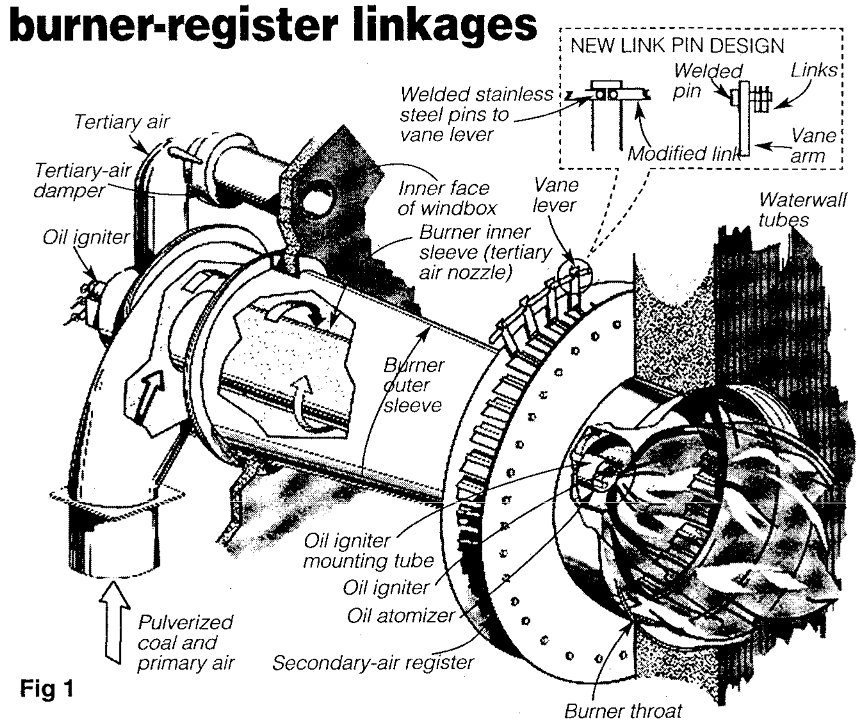

Fig 1

Analyze flame parameters on-line to improve combustion control

Burner flames are usually monitored for safety reasons. Example: When a flame failure is detected, the fuel valve automatically closes to prevent an explosion. Detectors also verify the presence of a pilot flame before main fuel is fed to a burner. More advanced systems may use a combination of detectors to monitor flame flicker, a basic indication of flame stability. Still, the information generated by these systems rarely influences the control and optimization of combustion. In an effort to improve efficiency, lower operating costs, and reduce emissions from its powerplants, the utility Imatran Voima Oy (IVO), Vantaa, Finland, integrates flame monitoring and analysis into the combustion-control scheme. The system, called Digital Monitoring and Analysis of Combustion (Dimac) by IVO, is now installed at five powerplants on two different types of boilers firing a variety of fuels.

Here's how Dimac works: Air-cooled semiconductor-type cameras monitor individual burners. Each camera is mounted within a protective housing and protrudes into the furnace at a 90-deg angle to the burner being monitored (Fig 2). The cameras generate analog video signals, which are converted to a workable digital form in the system's image-analyzing boards.

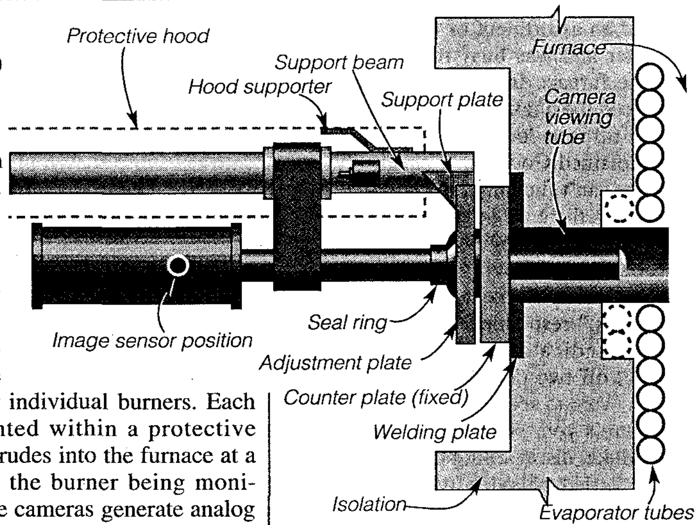

Fig 2

The flame image is divided into very small increments, each of which corresponds to one of 256 gray-scale values. These digital values are then processed to measure combustion-related parameters. Using digital values also permits the stor-

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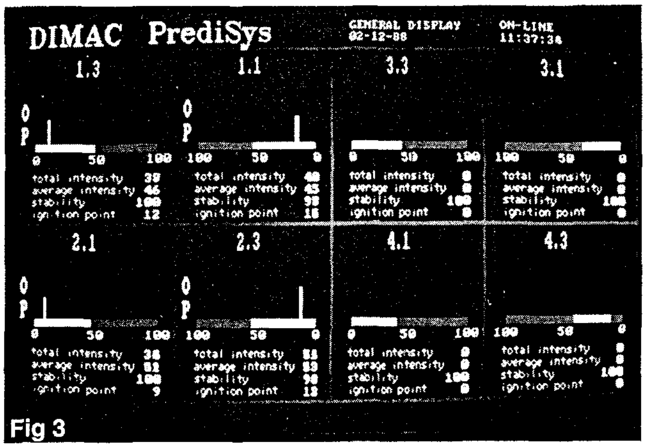

Fig 3

age of large amounts of data for trending and record keeping.

The following indicators, all scaled from 0 to 100, are evaluated (Fig 3):

- **Wall-fired units:** (1) the position of the ignition point relative to the burner mouth, (2) average flame intensity, (3) total flame intensity, and (4) stability—or flicker—at the ignition point.
- **Tangentially fired units:** (1) position of ignition point on the fuel stream, (2) stability of the ignition point, (3) height of the fuel stream, (4) upper flash point in the combustion window, and (5) lower flash point in the combustion window.

For both types of systems, the indicators are correlated to burner-specific combustion parameters, which are then manipulated to raise efficiency, lower emissions, and improve overall combustion control. These parameters include:

- **Air distribution.** Flame shape, stability, and intensity vary in relation to different combinations of firing rates and mill and burner settings. Ideal flame characteristics for these combinations are established during system commissioning. Through trial and error, air-flow adjustments can be preset for each combination. Maintaining accurate air-flow control reduces slagging, excess-air requirements, and unburned carbon in the ash.
- **Fuel distribution.** Changes in the fuel distribution can be identified by visual monitoring of the flame. Flow varies because of changes in the firing rate, quality of fuel fired, and/or as a result of switching pulverizers. Thus, flame monitoring is one alternative to direct measurement of fuel flow when balancing fuel distribution to the burners.
- **Auxiliary burner control.** Plants burning low-grade fuels sometimes use oil- or gas-fired auxiliary burners to stabilize the combustion process. Because advanced flame monitoring identifies instability before the flame is lost, the amount of auxiliary fuel required can often be reduced.

Case history. IVO's first Dimac system was installed at the 80-MW Rauhalahti station in 1988. The plant has a single, opposed-wall-fired boiler that burns a combination of fuels. Peat is the primary fuel; coal is used as a backup and for support during load changes and low-load operation; and fuel oil is used as a backup and when the plant operates at unusually low loads.

Information generated by the Dimac system has substantially improved performance at Rauhalahti, reports IVO:

- Burner-by-burner fine-tuning has reduced the plant's excess-O_2 requirements from 4.9 to 3.9%—improving boiler efficiency by 0.45% and saving $153,000 annually. Reducing excess O_2 by 1% has also cut NO_x production by 10%.
- Average consumption of auxiliary fuel oil has decreased from 6.4 to 3% of the total fuel supply for an annual saving of $80,000.
- Plant operators can detect burner problems without shutting down the unit. Through early detection of problems—such as slagging—plant personnel can schedule maintenance activities to correspond with a planned shutdown, thereby avoiding a forced outage. IVO engineers estimate that avoidance of forced shutdowns has saved over $40,000 annually.

Viton-coated belts seal leaking expansion joints

Each of two lines of ductwork connecting the air heater to the electrostatic precipitator at Ohio Power Co's Gavin station has 27 expansion joints. After nearly 20 years of service, many of the original metallic expansion joints were badly corroded and flue gas was leaking through to the atmosphere (Fig 4). These original joints consist of a double wall of Corten steel sandwiched around a layer of mineral-wool blanket insulation and protected from the flue-gas stream by a metal dust shield.

Plant personnel determined that all of the expansion joints would require replacement—an expensive undertaking. Replacing all 54 would require nearly $1.9-million in labor and $810,000 in materials, for a total replacement cost of $2.7-million.

Gavin's Elwood Lewis and American Electric Power Service Corp's (AEP) Glenn Davis devised an alternative to complete replacement: seal the existing joints in place. To do this, the existing metal dust shields were replaced with tough, 3/16-in.-thick, Viton-coated, fabric-belt expansion joints (Fig 5). The belts, which look similar to black rubber mats, form a sturdy barrier inside the existing expansion joints.

To ensure a tight seal, plant personnel welded new steel frames on top of the backup bars of the original expansion joints. Next, threaded Corten studs, preattached to support bars, were welded to the frames. To ease final installation, the belt manufacturer prepunched stud holes near both edges of the belts. Thus, each belt was simply spliced to size, then secured in place with washers and locknuts.

Although the total material costs for the belts was similar to buying all-new metal joints, labor costs were reduced to $500,000—a total saving of over $1.4-million. According to plant personnel, all 54 expansion joints have now been rebuilt in this way. Some have been in service for over six years. Inspection of the belts indicates that they should last at least eight to 10 years. Replacing belts will be relatively easy. One notable side benefit is that all work is performed inside the ducting. Thus the expense and added danger of working on ladders and exterior scaffolding is eliminated. ■

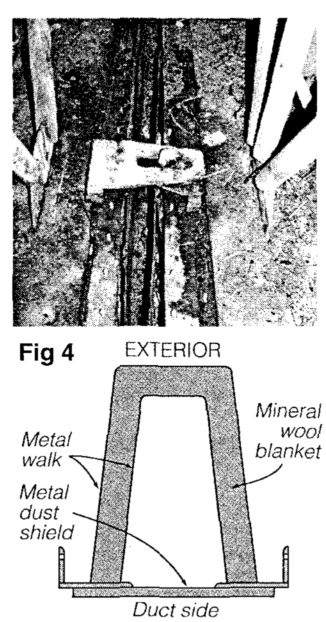

Fig 4

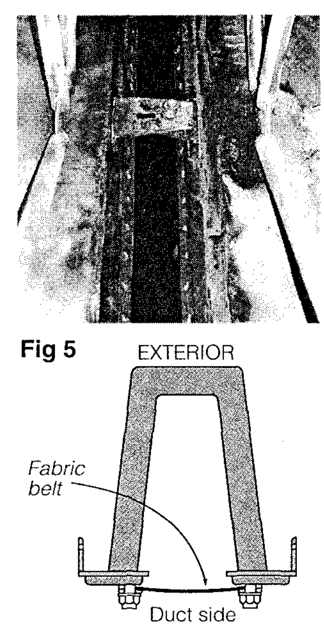

Fig 5

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